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WISCONSIN UNIV-MADISON DEPT OF PHYSICS J E LAWLER
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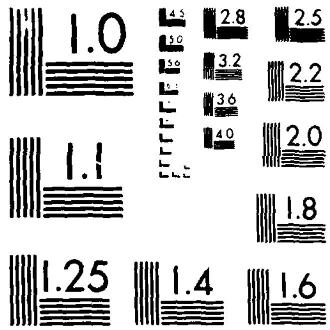
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The equipment acquired under a DOD University Research Instrumentation Program Grant is described. Applications of the equipment in ongoing DOD sponsored research on optogalvanic effects is reported.

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AFOSR-TR- 86-0518

Final Technical Report

to the

Air Force Office of Scientific Research

Grant AFOSR-84-0298

under the

University Research Instrumentation Program

Principal Investigator: J. E. Lawler

Three pieces of capital equipment were acquired under this grant. All are being used in ongoing experimental research on optogalvanic effects (AFOSR-84-0328). Optogalvanic effects are changes in the conductance of a gas discharge caused by illumination with radiation at a wavelength corresponding to an atomic or molecular transition. We are studying these effects in order to produce a more quantitative understanding of discharges and of laser-discharge interactions. We expect that a better understanding of laser-discharge interactions will ultimately lead to the development of a laser controlled repetitive opening switch for pulsed power applications.

We are especially interested in discharge sheaths, such as the cathode fall. Optogalvanic effects have a natural amplification mechanism in the cathode fall.[1] The cathode fall region is the least understood part of the discharge, and yet it is the most important part for many discharge applications. Discharge sheaths are the key regions in applications such as plasma processing of materials and semiconductors. The cathode fall region is critical in the operation of hollow cathode lasers. Discharge instabilities in high power diffuse discharge lasers and switches usually originate in the cathode fall region. Our research has led to the development of powerful new discharge diagnostics, such as those based on optogalvanic detection of Rydberg atoms.[2,3] These diagnostics are leading to a more quantitative understanding of the cathode fall region.

The first item acquired under this grant was a Laser Technics Model 100 Fizeau Wavemeter. This device makes it possible to quickly and efficiently set the wavelength of our pulsed dye lasers to part per million accuracy. This laser wavemeter is based on a Fizeau interferometer which produces fringes of equal thickness. These fringes (~500) are all detected simultaneously using a linear photodiode array. A small computer is used to analyze the fringe

pattern and determine the laser wavelength. This wavemeter is well suited for use with pulsed or c.w. dye lasers. Other wavemeters based on Michelson interferometers which have moving mirrors and which involve sequential detection of fringes are not suited for use with pulsed lasers. Pulsed dye lasers typically have very low ($\sim 10^{-7}$) duty cycles. We built a cart for the Fizeau wavemeter and associated computer and oscilliscope. It is now shared among three laser laboratories and is in steady use.

The second item we purchased was a Spex 1403 Double Spectrometer. A double spectrometer with large holographic gratings, such as this one, produces very good rejection of stray light (approximtely 10^{-14} when 20 cm^{-1} off the bandpass). This exceedingly high rejection is essential in a variety of fluorescence and scattering experiments in discharge plasmas. It makes it possible to see very weak signals against bright background light at nearby wavelengths. We have no other instrument which achieves comparable performance. The Spex 1403 Double Spectrometer has also been built into its own cart so that it can be shared among several laser laboratories.

The final item we purchased under this grant was a Spellman High Voltage Regulated Power Supply. This is a 3 kV supply which can deliver 0.5 Amp. It is regulated to 0.01%. We need it to run large stable discharges. Optogalvanic diagnostics achieve maximum sensitivity in stable well behaved discharges. The high degree of regulation is essential if we are to get the maximum amount of information from optogalvanic diagnostics.

In summary three pieces of capital equipment were purchased under this grant including: a Fizeau laser wavemeter, a double spectrometer, and highly regulated high voltage power supply. All are being used in ongoing research on optogalvanic effects.

References

1. D. K. Doughty and J. E. Lawler, Appl. Physics Lett. 42, 234 (1983).

2. D. K. Doughty and J. E. Lawler, Appl. Physics Lett. 45, 611 (1984).

3. D. K. Doughty, S. Salih, and J. E. Lawler, Physics Lett. 103A, 41 (1984).

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